CATTLE KILL-FLOOR EFFICIENCY

Marketing Research Report No. 1056

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
in cooperation with
Oklahoma Agricultural Experiment Station

ACKNOWLEDGMENTS

The author wishes to acknowledge the help of the many plant operators who made their facilities available for this study and who also contributed many helpful suggestions for increasing the efficiency of kill-floor operations.

Companies that supplied valuable equipment data and other information were Koch Supplies, Inc.; Cincinnati Butcher's Supply Co.; Allbright-Nell Co.; V. D. Anderson Co.; and LeFiell Corp.

Credit is due Lowell Walters of Oklahoma State University and T. F. Webb of the USDA Livestock and Meat Marketing Laboratory for their comments and valuable suggestions for improving the manuscript.

Washington, D.C. Issued July 1976

CONTENTS

ILLUSTRATIONS

TABLES

CATTLE KILL-FLOOR EFFICIENCY

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ABSTRACT

Kill-floor efficiency was studied at 25 beef slaughterhouses processing 12 to 50 head per hour. Detailed time-and-motion data from four plants are analyzed, and suggestions for improving production efficiency are given. The information in this report may be used to estimate labor and equipment requirements for new plants and to evaluate the efficiency of work methods in existing facilities. **KEY WORDS: cattle, efficiency, kill floor, labor requirements, on-the-rail systems, productivity, slaughtering, time-motion studies.**

INTRODUCTION

The total number of cattle slaughtered in the United States has increased during the past 10 years at an average annual rate of approximately 1 million head. This has required not only enlargement of existing facilities and construction of new plants, but also a continued search for more efficient methods of slaughtering. The two major changes in slaughter methods during this period were the adoption of mechanical hide pullers or strippers and on-the-rail systems as a preferred method of processing cattle through the slaughtering and dressing operations.

This study sets forth some basic labor requirements for the slaughter of cattle in production ranges of 12 to 50 cattle per hour and provides guidelines for achieving an acceptable efficiency level. Case studies were made of cattle kill floors in 25 plants in Texas, Oklahoma, Ohio, Nebraska, Minnesota, Louisiana, Colorado, Kansas, and Missouri. The plants handled all types of cattle, but variations in work arising from grade, breed, or condition of animals before slaughter are not specifically evaluated in this report. Work done by inspectors is also excluded.

Time-and-motion studies were made of all operations performed on the cattle kill floors in several plants with different volumes; however, work arrangements often varied considerably in plants producing the same volume with similar equipment. The data presented here relate primarily to the most commonly used methods and equipment, although some unusual equipment was evaluated. The time values shown for the operations are not standards, but guides for estimating the relative efficiency of an operation.

Timestudy data were obtained for all work done on cattle kill floors, from the stun operation through the final line operations (weigh, wash, or shroud). Line-support work such as head wash, head trim, pluck workup, and certain operations performed by utility workers (transporting paunches, hides, and trolleys, etc.) were also studied and evaluated. Support operations are not discussed in detail, but are considered only in the total time for a given number of men and jobs. The effects of such variables as cattle weight and sex, equipment, layout, work methods, and inspection procedures upon the efficiency of a line output were evaluated.

Line operations include all work on a carcass while it hangs on the rail and that work performed in the stun pen and dry-land area. These generally include such major jobs as stunning, dry landing, bleeding, head skinning, foreleg removal, high-bench and transfer work, rim-over, hide pulling, evisceration, splitting, washing,

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shrouding, and weighing. Driving of cattle, if done by the stunner, was included in line operations.

Line-support operations vary considerably by area of the country, market requirements, and general plant layout. One plant employed three workers to save and bone forelegs, which most plants discard to the renderer. Differences in labor sometimes result from saving tripe or doing some support work on the kill floor; other plants may do the same work in another location and charge it to a different department. Because of the many variations, only that work common to most plants was included in the evaluation phase of the field studies.

The production range of the plants in the study was 12 to 50 head per hour; these cattle had average dressed weights as follows: cows, 450 pounds; heifers, 550 pounds; steers, 650 pounds; bulls, 850 pounds.

Case studies revealed some significant items bearing on plant efficiency. Carcass-weight range, for instance, varied from 67 pounds in one efficient plant to 588 pounds in a less efficient plant. Most of the plants studied were designed to produce in one of these rate ranges: 12–15 head per hour; 25–35 head per hour; or 40–50 head per hour. Plants representative of these three typical ranges were selected for analysis and discussion in this report. Labor requirements for a plant rated at 36 head per hour are presented to illustrate the job arrangements required when a down-pull hide removal unit is used.

The timestudy data given in the tables of this report have been leveled to compensate for the speed of the workers. Consequently, the base times represent the time required for a skilled employee to perform the job at a normal pace under particular plant conditions. Fatigue and personal allowances are shown for each element. Personal allowance in each case is 5 percent, the remaining allowance being allocated to fatigue.

The leveling factor, which determines whether the worker is producing at a normal rate or above or below it, is a judgment factor established by the timestudy engineer for the actual average time observed for each element. For example, he may estimate that a particular worker is working at a rate of 115 percent of normal or at 85 percent of normal. The formula to determine base time is then: base time= (actual average time observed) $\times$ (leveling factor in percent$\div$100).

The fatigue allowance is also a judgment factor, but an experienced timestudy engineer also has much upon which to base his judgment. Fatigue allowances in this report vary from 10 to 20 percent depending upon individual job requirements. Each element of an operation is assigned a fatigue factor judged to be fair for that level of difficulty.

PLANT A

Plant A was located in the Midwest and slaughtered cattle weighing 525 to 670 pounds, dressed, during the study; 65 percent of these were steers, 32 percent were heifers, and 3 percent were cows and bulls. The overall average dressed weight was 596 pounds. Employees on the kill floor included 21 line workers and 10 line-support workers (1 for pluck workup, 5 for head workup, 2 for viscera workup, and 2 for utility work). Table 1 lists all operations as timed by operational elements, the base times (average leveled times) of all observations made during the time-and-motion studies, fatigue and personal allowances in percent, and productive time (the sum of base time and allowances). Fractions shown at the ends of some job elements in the tables indicate how often the element is performed—for example, 3/5 means 3 times out of each 5 cycles or carcasses.

DISCUSSION AND ANALYSIS

As a first step in evaluating plant A, consider the data in table 2. Line operations on kill floors using similar equipment can be compared more accurately than total kill-floor work, including supporting operations. Dividing total man-minutes into 60 minutes per hour, we obtain a figure of 2.10 carcasses per man-hour, which gives an indication of the line's relative production efficiency.

During this research, the most efficient kill floor studied put out 2.72 carcasses per man-hour; however, that plant paid incentive wages to its kill-floor employees. Most of the plants produced 1.6 to 1.8 carcasses per man-hour; consequently, plant A's 2.10 factor is on the better side of the efficiency range.

From table 3, it can be noted that total labor

(Continued on page 7.)

TABLE 1.—*Productive labor required per head for plant A kill-floor operations*

[Handling cattle dressing out to 525–570 pounds; 44 head per hour; powered on-the-rail system; up-pull hide removal unit]

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Drive, stun:			
Drive 1–3 animals into stun pen (open and close pen chute door), prod animals into position	0.19	15	0.22
Stun average of 2 animals (use long-handled, air-operated, captive-bolt stunner)	.40	15	.46
Actuate switch to raise pen door, release air stun gun	.05	15	.06
Drive 6 animals into stun pen chute, close air-operated door	.28	15	.31
Total	.92	....	1.05
Dry-land:			
Get shackle from shackle-return rail	0.20	17	0.23
Shackle left hindleg, place trolley wheel on hoist hook	.21	17	.25
Hoist and land on bleeding rail[1]	.25	15	.29
Lower hoist hook	.24	15	.28
Hoist animal by foreleg for better position (3/5)	.21	15	.24
Total	1.11	....	1.29
Stick, skin head:[2]			
Stick and bleed (at 1st rail stop)	0.13	17	0.15
Wash hands and tools	.13	15	.15
Walk to 2d rail stop, cut across poll	.14	17	.16
Scalp and right face	.29	17	.34
Left face, cut head loose to hang by trachea	.39	17	.46
Release 2 rail stops to move carcasses	.08	15	.09
Total	1.16	....	1.35
Clear neck, remove forelegs (performed by 2d-crew worker in bleed area):			
Open hide, neck to brisket (use hand knife), turn carcass	0.13	17	0.15
Clear neck and trim	.42	17	.49
Rod weasand	.12	17	.14
Tie weasand	.10	15	.12
Wash hands and tools	.12	15	.14
Remove left foreleg, throw in tub truck	.12	17	.14
Remove right foreleg, throw in tub truck[3]	.13	17	.15
Total	1.14	....	1.33

See footnotes at end of table.

TABLE 1.—*Productive labor required per head for plant A kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
1st hindleg, high bench:			
Open crotch to navel	0.12	17	0.14
Rip hide, skin right hindleg, open gam, score leg	.36	17	.42
Get mechanical knife, skin right flank to navel, partially skin right rump	.45	17	.53
Wash hands and tools	.07	15	.08
Total	1.00	....	1.17
Transfer, high bench:			
Get cutter (hydraulic), remove left hindleg, aside cutter, sterilize[4]	0.12	15	0.14
Walk back to 2d station, inspect and remove udder or pizzle, drop into truck	.29	15	.33
Get trolley, hang in right gam	.05	15	.06
Get cutter, remove right hindleg, aside cutter, leg in truck	.11	15	.13
Wash hands and tools	.08	15	.09
Lower carcass by power drop rail	.11	15	.13
Release shackle (returns to dry-land area)	.07	15	.08
Hang trolley wheel on dressing rail	.08	15	.09
Get trolleys from lift, hang on back of bench rail (3/5)	.15	15	.17
Total	1.06	....	1.22
2d hindleg, high bench:			
Skin left hindleg, open gam, score leg, drop in truck[5]	0.38	15	0.44
Get and aside mechanical knife, skin flank to navel, partially skin left rump	.41	15	.47
Get trolley, insert in left leg gam	.06	15	.07
Hang trolley wheel on low rail[6]	.08	15	.09
Wash hands and tools	.08	15	.09
Total	1.01	....	1.16
Rim-over:[7]			
Open breast hide down to neck opening	0.11	17	0.13
Get mechanical knife, skin right brisket	.24	17	.28
Skin left brisket, aside knife	.24	17	.28
Use hand knife to clear forelegs	.16	17	.19
Get mechanical knife, skin around forelegs and shoulder	.24	17	.28
Wash hands and tools, raise platform	.09	15	.10
Total	1.08	....	1.26
Rump:			
Get mechanical knife, rump both sides of carcass	0.56	15	0.64
Use hand knife to drop bung	.24	15	.28

See footnotes at end of table.

TABLE 1.—*Productive labor required per head for plant A kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Rump—Continued:			
Get string, tie bung	.16	15	.18
Wash hands and tools	.06	15	.07
Total	1.02	....	1.17
Skin neck, saw brisket:			
Get mechanical knife, skin back of forelegs, shoulder and neck, aside knife	0.74	17	0.87
Get saw, saw brisket, sterilize saw, aside saw	.24	15	.28
Wash hands	.09	15	.10
Score brisket	.06	15	.07
Total	1.13	....	1.32
1st hide puller:			
Get leg chain, attach to left foreleg	0.13	15	0.15
Pull carcass onto dead rail	.19	20	.22
Attach chain to stanchion	.06	15	.07
Get hide chain (hand 1 end to 2d hide puller), attach to hide and pull chain	.15	15	.17
Get mechanical knife, follow hide pull while raising hydraulic platform, aside knife	.41	15	.47
Lower platform, wash forelegs, release leg chain	.15	15	.17
Help push carcass onto power rail, remove other leg chain	.09	18	.11
Total	1.18	....	1.36
2d hide puller:			
Get chain, attach to right foreleg	0.12	15	0.14
Help pull carcass onto dead rail[8]	.14	18	.17
Attach chain to stanchion	.06	15	.07
Get chain, attach to hide	.11	15	.13
Follow hide pull with mechanical knife	.43	15	.49
Use hand knife to cut tail loose (while platform is at top of rise)	.14	15	.16
Lower platform, push carcass onto power rail	.17	18	.20
Total	1.17	....	1.36
Eviscerate:			
Open cavity	0.06	17	0.07
Eviscerate onto moving-top viscera table, wash cavity	.46	17	.54
Remove pluck and liver	.38	17	.44
Trim inside cavity (2/5)	.04	15	.05
Wash hands and tools	.21	15	.24
Total	1.15	....	1.34

See footnotes at end of table.

TABLE 1.—*Productive labor required per head for plant A kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
1st trim:[9]			
Remove end of tail joint, aside to tub	0.05	15	0.06
Remove tail, aside to table	.06	15	.09
Trim hind area of carcass	.47	15	.54
Wash hands and tools	.06	15	.07
Total	.64	....	.76
Split carcass:			
Grasp saw, raise platform	0.13	15	0.15
Saw carcass as platform lowers (worker moves sideways on 10-foot-wide platform to compensate for power rail movement)	.72	17	.84
Walk back to other side of platform, release saw	.06	15	.07
Total	.91	....	1.06
Scribe, trim:			
Get power scribe saw, scribe each side, pound back, aside saw. Trim 1 side	0.28	15	0.32
(save sweetbreads)	.31	15	.36
Trim other side	.30	15	.35
Sterilize knife, wash side	.14	15	.16
Total	1.03	....	1.19
2d trim:			
Trim 1 side, pop kidney	0.42	15	0.48
Trim other side, pop kidney	.40	15	.46
Wash hands and tools	.07	15	.08
Total	.89	....	1.02
Weigh:			
Pull side onto scale (8 feet), get peg	0.09	18	0.11
Peg neck	.09	15	.10
Record weight, write weight on tag, tag side	.27	15	.31
Pull side off scale	.07	18	.08
Side total	.52	....	.60
Carcass total	1.04	....	1.20
Wash:			
Wash 1 side (using hydraulic lift platform)	0.58	15	0.67
Wash other side	.56	15	.64
Total	1.14	....	1.31
High-shroud:			
Get shroud from tank, wrap hindleg, 2 pins (round and tail)	0.38	15	0.44
Score flank	.05	15	.06

See footnotes at end of table.

TABLE 1.—*Productive labor required per head for plant A kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
High-shroud—Continued:			
Release rail stop, carcass moves to low shroud	.06	15	.07
Get shroud, wrap leg of second side (2 pins)	.38	15	.44
Score flank	.05	15	.06
Release rail stop	.05	15	.06
Get bundle of shrouds from cart, place in tank	.12	15	.14
Get pins from bucket	.04	15	.05
Total	1.13	....	1.32
Low-shroud:			
Fold shroud under neck (2 pins), back and brisket	0.18	15	0.21
Pin inside flank (1 pin)	.10	15	.12
Pin outside flank (1 pin)	.07	15	.08
Pin low ouside shoulder (1 pin)	.06	15	.07
Release rail stops, move side to cooler door (10 feet)	.07	17	.08
Get pins from table	.02	15	.02
Side total	.50	....	.58
Carcass total	1.00	....	1.16

[1] After landing on bleed rail, animal rolls to first rail stop.
[2] Worker alternates working on 6 or 7 animals in bleed pit at 1 time.
[3] Carcasses move onto powered rail after bleed pit work.
[4] This is performed at 3d station after 2d hindlegger has performed his 1st element.
[5] 2d high-bench worker severs leg with hydraulic cutter.
[6] Takeup chain moves carcass into position.
[7] Worker actuates hydraulic platform to facilitate job.
[8] Rail in front of hind puller is not powered.
[9] Step-up stationary platform used.

per carcass for all workers assigned to the kill floor is 42.16 man-minutes; 60 minutes divided by this figure gives 1.42 carcasses per man-hour. The drop in relative efficiency when the support workers are added is due to the large number of head workup employees.

Another significant factor appears in table 1; the slowest operations in the "productive time" column, "first hide puller" and "second hide puller," require the same time—1.36 man-minutes per head. Job-regulated wait, or unproductive time, is then determined by calculating the difference between each of the other operations and these longest times, since each of the other workers will have to wait for the difference in time. Table 2 shows that this total unproductive time is 3.16 man-minutes per carcass.

A primary reason for analyzing a production line is to try to shift job elements in such a way as to arrive at a perfectly balanced line, in which all operations are of the same length. Of course, this is not possible on a kill floor, but each kill-floor manager must continually strive to come as close as possible to a balanced line through management of equipment, personnel, and job elements. Doing this job effectively requires much ingenuity on the part of the kill-floor supervisor.

LINE OPERATIONS

Table 1 presents the time elements which make up each kill-floor operation in plant A. The first

two operations, "drive, stun" and "dry-land," show that an average of two animals were handled at a time in the stun pen, rather than one at a time. This approach sometimes causes more delay time to get them into position for shackling or stunning than is saved by multiple stunning.

The "stick, skin head" operation is normally performed next in a kill line, using the up-pull type of dehider. In plant A, this operation was perfectly balanced with the slowest operation in the line, even though base time was faster. In this case, the "skin neck, saw brisket" operator was the pace setter; however, this was due to his inexperience in that job. Leveled time indicates the hide-pulling work set the pace for this line, largely because of plant layout and arrangement.

High-bench work (fig. 1) seemed to give supervisors the most headaches in training workers and organizing the work. Several variations of handling equipment and job element arrangements have been used in on-the-rail plant operations, and it is not easy to train and keep skilled workers in this area.

TABLE 2.—*Crew organization and labor requirements, plant A*

[44 head per hour; powered on-the-rail system; up-pull hide removal unit]

Operation	Crew size	Labor requirements (man-minutes)		
		Productive	Unproductive[1]	Total
Drive, stun	1	1.05	0.31	1.36
Dry-land	1	1.29	.07	1.36
Stick, skin head	1	1.35	.01	1.36
Clear neck, remove forelegs	1	1.33	.03	1.36
1st hindleg, high bench	1	1.17	.19	1.36
Transfer, high bench	1	1.22	.14	1.36
2d hindleg, high bench	1	1.16	.20	1.36
Rim-over	1	1.26	.10	1.36
Rump	1	1.17	.19	1.36
Skin neck, saw brisket	1	1.32	.04	1.36
1st hide puller	1	1.36	0	1.36
2d hide puller	1	1.36	0	1.36
Eviscerate	1	1.34	.02	1.36
1st trim	1	.76	.60	1.36
Split carcass	1	1.06	.30	1.36
Scribe, trim	1	1.19	.17	1.36
2d trim	1	1.02	.34	1.36
Weigh	1	1.20	.16	1.36
Wash	1	1.31	.05	1.36
High-shroud	1	1.32	.04	1.36
Low-shroud	1	1.16	.20	1.36
Total	21	25.40	3.16	28.56

[1] Job-regulated wait time, determined by taking the difference between each operation and the slowest line operation (1.36 man-minutes).

TABLE 3.—*Summary of labor requirements per head, plant A*

[44 head per hour; powered on-the-rail system; up-pull hide removal unit]

Operation	Labor requirements (man-minutes)		
	Productive	Unproductive	Total
Line	25.40	3.16	28.56
Support	13.60	....	13.60
Total	39.00	....	42.16

PN—4681

FIGURE 1.—High-bench transfer station, showing powered chain and shackle-return rail.

The amount of carcass trimming during dressing operations varied considerably among plants, depending on the type of cattle being slaughtered, amount of bruising, and the persons in charge of inspection. In plant A, 0.76 man-minute per carcass for the trim operation created excessive unproductive time for the trimmer while he waited for the eviscerator. Most plants try to utilize this free time by having the worker do such fill-in chores as washing down the floor and helping other workers.

"Split carcass" often incurs excessive unproductive time. The worker is usually on a hydraulic platform (fig. 2) where it is difficult for him to use his free time productively and still be ready for the next carcass on the line.

As shown in table 2, a total unproductive time of 3.16 man-minutes was calculated for plant A. The operations "drive, stun," "first trim," "split carcass," and "second trim" need to be looked at closely with the thought of moving other work elements to these jobs if possible. The high-bench work is fairly well balanced, but could possibly be improved upon.

The hydraulic cutter seemed to be the preferred method for removing hindlegs (fig. 3). Though timed somewhat slower than a saw, it is a safer piece of equipment, and when kept in good condition, performs competitively.

Most kill floors slaughtering at this rate were using a powered rail system. A powered takeup rail in the high-bench work area is a fast, easy method of carcass transfer.

The hide removal unit in this plant was the up-pull type requiring the forelegs to be anchored to a stanchion before hide pull (fig. 4). The main disadvantage of this type of puller is that dirt, manure, or hair from the hide may contaminate the carcass as it is being skinned.

For evisceration at this kill rate, most plants use a moving-top viscera table. This is an item whose initial cost is high, but it has the capacity to handle 40 to 45 head per hour (or more), better than the drop-rail systems used in smaller volume plants.

Support operations in this plant accounted for about 32 percent of the overall kill-floor time. The unproductive line time, 3.16 minutes, is in

PN—4682

FIGURE 2.—Carcass-splitting work performed from hydraulic platform.

PN—4683

FIGURE 3.—Hydraulic cutter being used to remove hindleg.

PN—4684

FIGURE 4.—Workers following hide with mechanical knives as it is removed by up-pull unit.

the lower range of unproductive times found during these studies. The timestudies showed that, in general, when unproductive line time is less than 25 percent of total productive line time, the plant is doing a better than average job of line balance. The 25-percent figure thus becomes a target below which floor supervisors should strive to keep their kill-line unproductive time for optimum efficiency. Since support time can vary so much among plants, depending upon several factors, definite guidelines for optimum support time cannot be established. In this study, support work actually performed on the kill floor took up 17 to 44 percent of the total kill-floor time.

PLANT B

Plant B was a Southwestern plant processing cattle that dressed out at 530 to 796 pounds while this study was being made. Of those cattle, 52 percent were steers, 36 percent were heifers, and 12 percent were cows and bulls. Their average weight was 654 pounds. The kill floor employed 16 line workers and 7 support workers, consisting of a head washer, head boner, paunch workup man, offal workup man, tripe workup man, paunch-truck mover, and utility worker. Table 4 presents the productive labor requirements for performing all the line operations observed during the timestudy.

(Continued on page 14.)

TABLE 4.—*Productive labor required per head for plant B kill-floor operations*

[Handling cattle dressing out to 530–796 pounds; 27 head per hour; gravity on-the-rail system; up-pull hide removal unit]

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Drive, stun, dry-land:			
Drive animals into stun pen (2–5 animals, average 3)	0.36	15	0.41
Lower chute door	.06	15	.07
Get gun, stun 1 animal, aside gun	.10	15	.12
Eject spent shell, reload	.11	15	.13
Empty stun pen	.02	15	.02
Shackle on hoist hook	.11	17	.13
Shackle left hindleg	.15	17	.18
Hoist and land on bleed rail	.25	15	.29
Lower hoist hook	.14	15	.16
Walk to latch pen door, walk to raise chute door	.10	15	.12
Total	1.40	....	1.63
Stick, skin forelegs:			
Open dewlap, stick	0.09	17	0.11
Skin and remove 1 foreleg, aside to general-purpose truck	.30	17	.35

TABLE 4.—*Productive labor required per head for plant B kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Stick, skin forelegs—Continued:			
Release rail stops, position carcass	.12	18	.14
Skin right face, trim hide	.33	17	.39
Skin 2d foreleg	.19	17	.22
Remove and aside 2d foreleg	.12	17	.14
Wash hands and tools	.10	15	.12
Total	1.25	....	1.47
Skin head:			
Pull rail stops	0.14	15	0.16
Wash hands and tools	.10	15	.12
Cut across poll	.11	17	.13
Skin left face, trim hide, scalp	.33	17	.39
Cut neck and atlas joint	.16	17	.18
Remove lips, trim	.11	15	.13
Total	.95	....	1.11
1st hindleg:			
Cut right hindleg pattern	0.10	17	0.12
Skin right hindleg, open gam	.33	17	.39
Use hydraulic cutter to partially cut leg	.11	15	.13
Use hand knife to remove leg, aside	.05	15	.06
Open tail hide to bung (3/10)	.09	15	.10
Pull rail stop, position carcass	.12	18	.14
Wash hands and tools	.06	15	.07
Total	.86	....	1.01
2d hindleg, transfer:			
Transfer — lower hoist, remove hoist hook from gam, insert hoist hook in gam of free leg, raise to shift weight of carcass to right leg, release shackle, lower hoist, pull shackle release, double shackle, guide on return rail	0.30	15	0.35
Wash hands and tools	.06	15	.07
Cut left hindleg pattern	.09	17	.11
Skin leg, open gam	.33	17	.39
Get 2 trolleys, release rail stop, place trolleys on spreader hooks, rotate and hoist carcass	.25	18	.29
Pull spreader into position, insert trolley hooks into gams, adjust hoist	.23	15	.26
Remove and aside leg (pneumatic cutter)	.11	15	.13
Total	1.37	....	1.60
Rump:			
Skin rump, aside mechanical knife	0.54	15	0.61
Wash hands and tools	.06	15	.07
Rim and drop bung, get string	.18	15	.21

TABLE 4.—*Productive labor required per head for plant B kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Rump—Continued:			
Tie bung	.09	15	.10
Release pizzle	.09	15	.10
Rotate carcass	.05	18	.06
Rip belly hide to brisket	.07	17	.08
Remove pizzle	.14	15	.16
Position carcass	.10	18	.12
Rip tail to bung, remove bung crown (7/10)	.15	15	.17
Total	1.47	....	1.68
Rim-over:			
Rip brisket hide to neck	0.11	17	0.13
Mark brisket	.06	17	.07
Raise platform	.07	15	.08
Rim-over left side down to brisket area	.55	17	.64
Rim-over right side to brisket area	.47	17	.55
Lower platform	.05	15	.06
Rim-over brisket, both sides	.52	17	.61
Wash hands and tools	.05	15	.06
Total	1.88	....	2.20
Clear neck, forelegs:			
Walk to carcass, remove ears, walk to work area, place ears in tray, aside, set in barrel	0.15	15	0.17
Skin neck and forelegs area	.45	17	.53
Skin shoulder to back of neck, both sides (mechanical knife)	.51	17	.60
Pull rail stop (7/10)	.06	15	.07
Step to next station, saw brisket, return (4/10)	.07	15	.08
Wash hands and tools (5/10)	.04	15	.05
Total	1.28	....	1.50
1st hide puller:			
Separate and tie weasand (3/10)	0.09	15	0.10
Pull rail stop, position carcass (rotate)	.20	15	.23
Sterilize hide chain, attach to hide and puller (6/10)	.12	15	.14
Get and attach leg chain to stanchion and leg	.14	15	.16
Mount hydraulic platform, get mechanical knife, follow hide pull, replace knife	.47	15	.54
Saw brisket	.18	15	.21
Release leg chain	.09	15	.10
Wash hands and tools	.04	15	.05
Total	1.33	....	1.53

TABLE 4.—*Productive labor required per head for plant B kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
2d hide puller:			
Get foreleg chain from stanchion, attach to right foreleg and stanchion, help attach hide chain	0.20	15	0.23
Separate and tie weasand (7/10)	.21	16	.24
Mount hydraulic platform, follow hide with mechanical knife, lower platform, aside knife	.47	15	.54
Release leg chain, hang on stanchion, pull rail stop	.11	15	.13
Walk to rear of hide puller	.07	15	.08
Remove tail switch, aside to barrel	.10	15	.12
Remove hide chain, position hide on truck, carry chain and hang on stanchion	.27	15	.31
Wash, sterilize leg chains	.08	15	.09
Total	1.51	....	1.74
Eviscerate:			
Pull rail stop, move carcass onto lowerator, lower to position	0.24	20	0.29
Position paunch truck under carcass neck	.24	18	.28
Open belly	.06	17	.07
Eviscerate—melt, liver to truck tray	.81	17	.95
Move paunch truck aside, position for inspection, separate pluck	.20	18	.24
Raise lowerator, pull stops for carcass to move to saw station	.15	15	.17
Wash hands and tools	.06	15	.07
Total	1.76	....	2.07
Split carcass:			
Raise platform	0.08	15	0.09
Remove tail tip and tail, aside to table	.18	15	.21
Position saw	.05	17	.06
Saw carcass into sides	.74	17	.87
Release sides, move on rail	.15	18	.18
Release spreader to return rail, new carcass moves into position	.17	15	.20
Trim carcass (4/10)	.07	15	.08
Empty ice pan, help carry pan of tails to cooler, push carcasses on rail to cooler (1/10)	.20	15	.23
Total	1.64	....	1.92
Trim:			
Trim 2 sides	0.96	15	1.10
Scribe 2 sides	.24	15	.28
Push sides on rail	.40	20	.48
Wash hands and tools	.06	15	.07
Total	1.66	....	1.93

TABLE 4.—*Productive labor required per head for plant B kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Wash (carcasses and area):			
Geared to line speed (stationary platform)[1]	2.20	....	2.20
Total	2.20	....	2.20
High-shroud:			
Get shroud, wrap on round	0.20	15	0.23
5-pin shroud	.45	15	.52
Get shroud, wrap, 5-pin on side	.65	15	.75
Total	1.30	....	1.50
Low-shroud, weigh:			
Pull side on rail to scale	0.07	15	0.08
Peg neck	.15	15	.17
Low-shroud (2 pins)	.17	15	.20
Pull side to scale, peg neck	.22	18	.25
Low-shroud (2 pins)	.17	15	.20
Stamp 2 sides	.10	15	.12
Weigh 2 sides, record on tags and record	.36	15	.41
Tag each side	.10	15	.12
Move both sides (15 feet) to cooler door, return to scale (5/10)	.10	20	.12
Push 4 sides into cooler, move 2 sides to cooler door from scale (5/10)	.28	25	.35
Total	1.72	....	2.02

[1] Not timed (assumed line speed).

DISCUSSION AND ANALYSIS

From the operation times shown in table 5, a line efficiency of 1.70 carcasses per man-hour is calculated for plant B. This plant is classified "average" in line efficiency.

Taking into account the support operations shown in table 6, plant B's total kill-floor efficiency drops to 1.19 carcasses per man-hour. This figure is in the lower efficiency range found in this study and is attributable to excessive unproductive line and support time. Since the job-regulated wait or unproductive line time is an above-average 8.09 man-minutes per carcass (one of the highest found during this study), it can be considered a major contributor to the overall low efficiency.

Table 5 shows that rim-over is the slowest line operation at plant B. This could be corrected by reassigning job elements between the high-bench work "clear neck, forelegs" and "rim-over" to obtain better balance. "Clear neck, forelegs" work could be increased advantageously. There is considerable imbalance between "skin head" and "first" and "second hindleg." In this plant, most of the imbalance was related to equipment and layout.

LINE OPERATIONS

In table 4, it is shown under "drive, stun, dryland" that an average of three animals were handled by the stunner at one time. This resulted in a greater than normal time to stun one animal.

The "skin head" operation could handle more of the job elements assigned to "stick, skin forelegs," considerably reducing the unproductive time for line operations. In fact, the "first hindleg," "second hindleg," "rump," "rim-over," and

"clear neck, forelegs" work could, in an efficient work arrangement, be handled by four workers instead of the five actually used.

One job element in the "rump" operation is "rotate carcass." At this plant, swivel spreaders were used after the carcass had been transferred from the bleed rail to the dressing rail in the high-bench area (fig. 5). These spreaders (fig. 6) convey the carcass on the rail until it is split into sides, which are then conveyed on trolleys into the coolers.

TABLE 5.—*Crew organization and labor requirements, plant B*

[27 head per hour; gravity on-the-rail system; up-pull hide removal unit]

Operation	Crew size	Labor requirements (man-minutes)		
		Productive	Unproductive[1]	Total
Drive, stun, dry-land	1	1.63	0.57	2.20
Stick, skin forelegs	1	1.47	.73	2.20
Skin head	1	1.11	1.09	2.20
1st hindleg	1	1.01	1.19	2.20
2d hindleg	1	1.60	.60	2.20
Rump	1	1.68	.52	2.20
Rim-over	1	2.20	0	2.20
Clear neck, forelegs	1	1.50	.70	2.20
1st hide puller	1	1.53	.67	2.20
2d hide puller	1	1.74	.46	2.20
Eviscerate	1	2.07	.13	2.20
Split carcass	1	1.92	.28	2.20
Trim	1	1.93	.27	2.20
Wash (geared to line speed)	1	2.20	0	2.20
High-shroud	1	1.50	.70	2.20
Low-shroud, weigh	1	2.02	.18	2.20
Total	16	27.11	8.09	35.20

[1]Job-regulated wait time, determined by taking the difference between each operation and the slowest line operation (2.20 man-minutes).

TABLE 6.—*Summary of labor requirements per head, plant B*

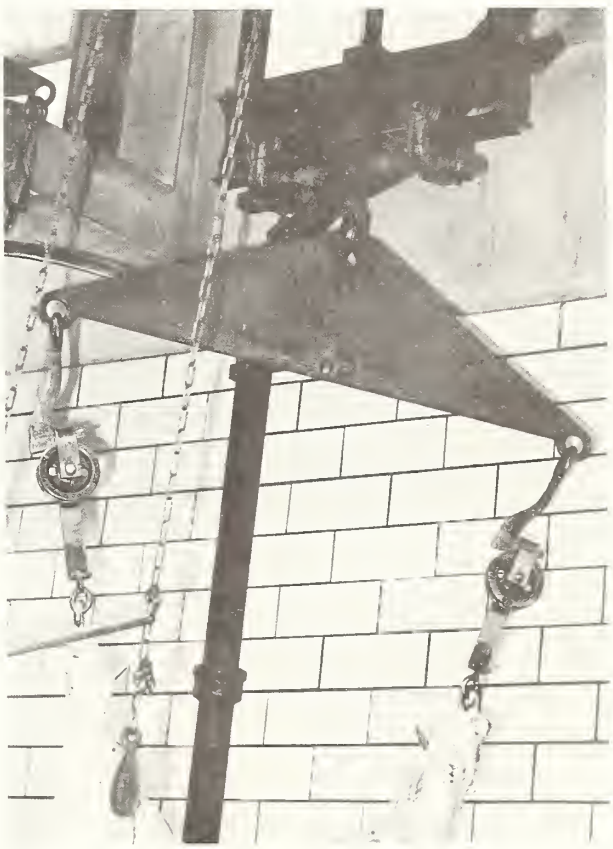
[27 head per hour; gravity on-the-rail system; up-pull hide removal unit]

Operation	Labor requirements (man-minutes)		
	Productive	Unproductive	Total
Line	27.11	8.09	35.20
Supporting	15.40	....	15.40
Total	42.51	....	50.60

A similar gravity system was used in all plants that slaughtered in ranges of 12 to 35 head per hour.

PN—4685

FIGURE 5.—High-bench station using gravity rail system.



PN—4686

FIGURE 6.—Widely used type of eviscerating station rail, with powered section to lower carcass to working level. Note swivel spreader.

The hide puller used in plant B was the up-pull type, the earliest type used in this country and still the most common. Some recent modifications such as rollers and guides for the hide as it is being removed from the carcass have evidently improved its acceptability to inspection services. One plant, in an unsuccessful attempt to satisfy inspection, used a large fan at the hide removal unit to exhaust dirt and other debris away from the carcass as the hide was removed. Still another plant used a novel method of eliminating ripping or splitting of the tail hide; this causes the hide to turn inside out as it is removed from the tail (fig. 7) and evidently prevents some of the debris from the hide from falling on the carcass as the hide leaves the tail.

Evisceration in plant B was handled with a drop-rail section (fig. 6) and paunch truck, a procedure most often used by on-the-rail plants slaughtering less than 40 head per hour. Such equipment generally limits the production rate of heavy cattle to 35 or 40 head per hour, although it is possible, under ideal conditions and with unusual personnel, to obtain about 60 head per hour fairly consistently. To achieve this rate, job elements such as moving the paunch truck must be handled by a utility worker.

PN—4687

FIGURE 7.—Hide removal by up-pull unit. Note that tail has not been slit.

The "split carcass" operation in plant B required more than the usual time for this work because the worker was doing work not entirely related to carcass splitting. In this case, however, he had the time to spare and was being utilized very well. If a production-rate increase is needed, a means to keep in mind is to assign as much of the work as possible to utility workers, leaving only the necessary carcass work to line workers.

The "wash" operation in most on-the-rail plants is geared to line speed as long as carcasses can be washed clean enough to pass inspection. For some higher kill rates a wash cabinet is added ahead of the normal washer to supplement it. This arrangement usually works out very well because any extra time at this station can be used to clean work areas and floors.

Plant B is a good example of a kill floor where, through better line balance and shifting of job elements to utility workers, considerable improvement in efficiency could be achieved. The total time shown in table 6, 50.60 man-minutes for kill-floor operations on one carcass, is excessive; another plant studied used only 38 man-minutes per carcass to accomplish a similar job.

PLANT C

Plant C was a Southwestern plant slaughtering cattle in a dressed-weight range of 386 to 840 pounds. The average carcass weight, dressed, during the study was 648 pounds. Of the cattle slaughtered, 50 percent were steers, 40 percent were heifers, and 10 percent were cows and bulls. Plant C maintained an average slaughter rate of 15 head per hour with 10 line workers and 5 support workers. The support workers included one paunch trucker, two head workup men, one viscera workup man, and one utility man. Table 7 presents the detailed operations broken down into job elements, with base and productive times for each element.

Plant C had the lowest kill rate studied and about the lowest production rate found in any on-the-rail slaughter plant. Most plants slaughtering less than 10 to 12 head per hour use the bed system of slaughter, usually because of their de-

sire to minimize capital outlay for equipment. Recently, however, more small plants have adopted an on-the-rail system.

DISCUSSION AND ANALYSIS

Not unexpectedly, plant C required the longest processing time per carcass. It also had a high unproductive time per carcass (table 8). Under normal conditions, up to some undetermined level, efficiency increases as the rate of kill increases. Even so, nearly all kill-floor work can be rearranged in some way to improve efficiency.

The standard line efficiency for plant C operations is 1.52 carcasses per man-hour, below the average range of 1.6 to 1.8 carcasses per man-hour for small- and medium-sized on-the-rail kill operations. The total kill-floor time, 59.25 man-minutes per carcass (table 9), results in an efficiency rate of 1.01 carcasses per man-hour. This figure is also in the low range of efficiency.

(Continued on page 21.)

TABLE 7.—*Productive labor required per head for plant C kill-floor operations*

[Handling cattle dressing out to 386–840 pounds; 15 head per hour; gravity on-the-rail system; budget up-pull hide removal unit]

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Drive, stun, skin forelegs:			
Drive 2 animals into stun pen	1.43	15	1.64
Walk to stunner's walk (36 feet) get stun gun, stun, reload, stun, aside gun	.82	15	.94
Walk to dry land, open pen door	.38	15	.44
Shackle right hindleg	.15	17	.18
Hoist and land on rail	.25	15	.29
Grasp foreleg, pull carcass to bleed, lower hoist hook	.25	20	.30
Open dewlap, stick 1st animal	.09	17	.11
Get shackle, place on hoist hook, shackle 2d animal	.26	17	.30
Hoist and land on rail, close pen door	.25	15	.29
Pull 2d animal to bleed	.25	20	.30
Open dewlap, stick	.09	17	.11
Remove both forelegs of 1st animal, aside to barrel	.25	17	.29
Remove both forelegs of 2d animal, aside to barrel	.30	17	.35
Wash hands and tools (sharpen knife, 1/3)	.20	15	.23
Walk to dry-land area (15 feet), get 2 shackles from shackle return rail, 1 on hoist hook, 1 on storage rail	.30	15	.35
Occasionally hoist animal by foreleg to position for shackling	.33	15	.37
Total cycle	5.60	....	6.50
Total/animal	2.80	....	3.25
Skin head:			
Pull rail stop, pull carcass on rail past stop, walk to next carcass	0.23	20	0.28
Cut across poll, remove ears and poll hide, aside to barrel, cut atlas bone	.60	17	.70
Scalp, skin right face, cut right neck, trim hide	.41	17	.48

TABLE 7.—*Productive labor required per head for plant C kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Skin head—Continued:			
Skin left face, walk around carcass, cut neck, trim	.32	17	.37
Separate, rod weasand	.26	17	.30
Sterilize rod, hang on wall hook	.09	15	.10
Tag head and carcass	.06	15	.07
Get string, tie weasand	.10	15	.12
Cut down head, hang on head rack hook in wash cabinet	.10	17	.12
Wash hands and tools	.10	15	.12
Total	2.27	....	2.66
1st hindlegger:			
Position carcass at work station, lower platform	0.20	18	0.24
Remove tail switch	.15	15	.17
Rim bung	.23	15	.26
Release bung	.24	15	.28
Tie bung	.09	15	.10
Open crotch hide to navel	.07	17	.08
Remove pizzle	.14	15	.16
Cut left hindleg pattern	.09	17	.10
Skin leg, open gam	.33	17	.39
Skin flank	.20	17	.23
Cut off leg, aside, lower drop rail (pneumatic cutter)	.11	15	.13
Get trolley, insert in gam, hang wheel on rail	.13	15	.15
Raise hoist to rail	.12	15	.14
Release shackle, double chain, pull rail stop for shackle return	.17	15	.20
Skin right hindleg	.32	17	.37
Cut off right hindleg	.11	15	.13
Pull rail stop, push carcass to next station	.14	18	.17
Get trolleys, hang on bench railing (1/5)	.12	15	.14
Total	2.96	....	3.44
Rim-over, transfer:			
Pull rail stop, move carcass from work station	0.13	18	0.15
Pull rail stop, pull carcass to work station (raise hydraulic platform)	.13	18	.15
Open gam, open hide on round	.11	15	.13
Skin round and flank	.33	17	.39
Get trolley, insert in gam	.09	15	.11
Lower drop-rail section, trolley wheel on rail, raise rail, pull rail stop to allow left leg to move onto drop rail	.17	15	.20
Open hide to neck area (hand knife)	.11	17	.13
Rim-over, left and right sides (mechanical knife)	.93	17	1.09

TABLE 7.—*Productive labor required per head for plant C kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Rim-over, transfer—Continued:			
Skin inside forelegs and neck, aside knife	.40	17	.47
Wash hands and tools	.10	15	.12
Trim hide (2/5)	.10	15	.11
Total	2.60	....	3.05
1st hide puller (budget hide stripper used):			
Pull rail stops for carcass to move into position, descend platform	0.13	15	0.15
Guide hide into barrel, release chain, lower roller	.45	15	.52
Walk to stand, use mechanical knife to skin shoulder and neck area	.26	17	.30
Sterilize knife, aside	.06	15	.07
Attach chain to foreleg and stanchion	.15	15	.17
Attach chain to hide, fold hide	.12	15	.14
Get mechanical knife, step up, actuate hide pull, follow pull with mechanical knife	.60	15	.69
Sterilize knife, aside, step down	.06	15	.07
Release leg chain, sterilize chain	.12	15	.14
Wash hands and tools	.06	15	.07
Move barrels (4/10)	.15	25	.19
Total	2.16	....	2.51
2d hide puller:			
Get mechanical knife, skin shoulder and neck area	0.30	17	0.35
Sterilize and aside knife	.05	15	.06
Attach leg chain	.12	15	.14
Attach hide chain	.13	15	.15
Get mechanical knife, step up, follow hide pull	.54	15	.62
Step down, sterilize and replace knife	.08	15	.09
Open breast fat with hand knife, position carcass	.20	16	.23
Pull rail stops, step up	.09	15	.10
Saw brisket, sterilize saw, pull rail stops	.26	15	.30
Wash hands and tools	.05	15	.06
Total	1.82	....	2.10
Eviscerate:			
Release rail stop, allow carcass to move onto spreader	0.15	15	0.17
Spread carcass, lower drop rail	.09	15	.10
Eviscerate into paunch truck, pluck and liver into truck tray	.87	17	1.02
Pop kidneys	.15	15	.17
Pull paunch truck aside	.15	18	.18
Raise drop rail section, pull rail stop	.15	15	.17

TABLE 7.—*Productive labor required per head for plant C kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Eviscerate—Continued:			
Condemned livers, bladders, etc. to barrel, trim carcass, cut tail muscle, score flanks	.60	15	.69
Wash hands and tools (2/5)	.06	15	.07
Wait on paunch truck (9/10)	.54	15	.62
Wait on inspector (4/5)	.64	15	.63
Total	3.40	....	3.82
Split carcass:			
Pull rail stops, partially raise hydraulic platform, spread carcass	0.35	15	0.40
Get mechanical knife, trim back, trimmings to barrel	.30	15	.35
Raise platform, position saw	.12	15	.14
Saw carcass as platform descends	.73	17	.85
Step off platform, trim chuck and neck area, push carcass sides on rail	.87	18	1.03
Pull rail stops, move sides to wash (3/10)	.10	20	.12
Change barrels for trimmings (1/45)	.05	25	.06
Total	2.52	....	2.95
Wash (carcasses and area): Geared to line speed (stationary platform)[1]	3.95	....	3.95
Total	3.95	....	3.95
Shroud, weigh:			
Scribe each side and pound back	0.34	15	0.39
Ascend platform, raise, get shroud pins, aside scribe saw	.14	15	.16
Get shroud, pin on round, remove tail, position side	.58	16	.67
Puncture round joint (on carcasses 600 lb or more)	.26	15	.30
Descend platform, move sides to scale	.10	20	.12
Dry hands, record weight on 4 tags and register	.36	15	.41
Tag both sides	.15	15	.17
Get pins, low-shroud each side, 6-pin each	.90	15	1.03
Stamp sides, aside stamp	.10	15	.11
Push carcass sides to cooler	.47	25	.59
Total	3.40	....	3.95

[1] Because of the difficulty in determining the required amount of washing to adequately clean a carcass, this operation was not timed. Time of pace-setting operation is assigned to this operation.

Probably the two largest factors in the low efficiency of plant C were the large average weight of carcasses and the wide range of weights. Undoubtedly, this kill floor could have processed lighter, more uniform carcasses with a higher degree of efficiency.

Wide diversity in weights was a causative factor in the low efficiency of many of the plants studied. The average plant slaughtered animals having a 400- to 600-pound weight range almost daily; in contrast, three of the most efficient plants consistently slaughtered animals whose weight range was 67 to 235 pounds.

Frequent changes from one weight of carcass to a drastically different one can play havoc with efficiency. A large bull can require as much as five times the labor to process as a calf. There are also less drastic differences in times required to process heifers, steers, and cows because of weight and slightly different requirements for processing each class of animal. Also, during the winter months particularly, muddy cattle can cause considerable inefficiency in skinning work. Plants should take this into consideration during buying transactions.

TABLE 8.—*Crew organization and labor requirements, plant C*

[15 head per hour; gravity on-the-rail system; budget up-pull hide removal unit]

Operation	Crew size	Labor requirements (man-minutes)		
		Productive	Unproductive[1]	Total
Drive, stun, skin forelegs	1	3.25	0.70	3.95
Skin head	1	2.66	1.29	3.95
1st hindlegger	1	3.44	.51	3.95
Rim-over, transfer	1	3.05	.90	3.95
1st hide puller	1	2.51	1.44	3.95
2d hide puller	1	2.10	1.85	3.95
Eviscerate	1	3.82	.13	3.95
Split carcass	1	2.95	1.00	3.95
Wash (geared to line speed)	1	3.95	0	3.95
Shroud, weigh	1	3.95	0	3.95
Total	10	31.68	7.82	39.50

[1] Job-regulated wait time, determined by taking the difference between each operation and the slowest line operation (3.95 man-minutes).

TABLE 9.—*Summary of labor requirements per head, plant C*

[15 head per hour; gravity on-the-rail system; budget up-pull hide removal unit]

Operation	Labor requirements (man-minutes)		
	Productive	Unproductive	Total
Line	31.68	7.82	39.50
Supporting	19.75	....	19.75
Total	51.43	....	59.25

LINE OPERATIONS

In plant C the line operations "skin head," "first" and "second hide puller," and "split carcass" were most out of balance. Table 8 shows that the unproductive time on each of these operations is excessive; in this case, some job elements allocated to the first operation, "drive, stun, skin forelegs," should be switched to "skin head," if possible.

Similarly, in the "first" and "second hide puller" operations, a slight adjustment such as assigning some of the first hide puller's work to the second hide puller would create better line balance. Unfortunately, reducing the workload of the first hide puller would require assigning the hide handling to a utility worker or possibly adding another worker to the line. Since this plant did not have an immediate need to increase its volume, changes were needed only to increase efficiency or reduce existing unproductive labor.

A more even balance between "first hindlegger" and "rim-over, transfer," which could be achieved by moving a small part of the first hindlegger's work to rim-over, would also help reduce unproductive time.

As shown in table 8, the "shroud, weigh" operation was the line pacer. Reducing the time for this key operation would require that carcasses be moved to the chill room by a utility worker, but this could effectively change the entire efficiency picture for plant C. Normally, the eviscerator's work should be the pacing operation, and that would become the case here if the suggested changes were made.

These few minor changes should enable plant C to raise its production rate to 16 head per hour or more with the same personnel. The 7.82 man-minutes of unproductive line time (table 9) is

high, but a high figure is to be expected at lower kill rates.

During the time this kill floor was studied, the production rate averaged slightly less than 14 head per hour. The timestudies indicated that most of work was being done at a lower than normal rate, which was attributed mainly to slightly heavier than average cattle in muddy condition. The base times shown herein compensate for these factors.

The hide puller in this plant is the budget type especially designed for use in low-volume plants (fig. 8). Its operations are somewhat slower than more expensive units designed for higher kill rates. Timestudies showed that this hide puller took about 1.25 man-minutes more than the larger up-pull type to skin each carcass.

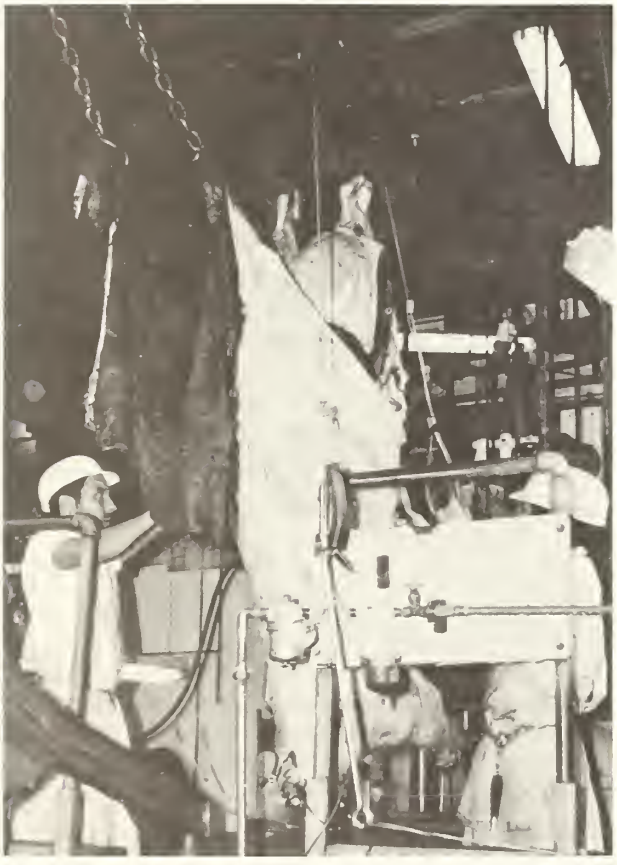
PLANT D

Table 10 presents the operations and detailed time elements required in a Midwestern plant slaughtering at the rate of 36 head of cattle per hour with a gravity on-the-rail system and a down-pull hide puller. There are three general types of down-pull units; the one used in plant D employs a drum to which the hide is attached by chains and pulled off the carcass as the drum descends and rolls (figs. 9–11). Hide removal proceeds from the hindquarters down over the head, rather than from the neck up.

The hind removal unit in use in plant D requires some deviations from the normal kill-floor line operation procedure. Head removal is left until after the hide-puller operation (fig. 12) so that the head can be skinned by the removal unit rather than manually. The bleeding area, where the head is usually skinned, is still required to stick, bleed, and remove forelegs, ears, and horns.

The down-pull hide removal unit is more expensive than the up-pull type, but reduces total skinning time. Plant D's down-pull unit saved an average of 2.19 man-minutes over the average skinning time for the up-pull units.

(Continued on page 26.)



PN—4688

FIGURE 8.—Small (budget model) up-pull hide removal unit with stationary work platforms. Note that forelegs must be chained to stanchion.

PN—4689

FIGURE 9.—Carcass prepared for down-pull hide removal unit.

TABLE 10.—*Productive labor required per head for plant D kill-floor operations*

[Handling cattle dressing out to 401–838 pounds; 36 head per hour; gravity on-the-rail system; down-pull hide removal unit]

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Drive, stun, dry-land:			
Drive animal into stun pen, close pen door	0.26	15	0.30
Get stun gun, stun animal, eject shell, reload, aside gun, release stun pen revolving door catch	.35	15	.40
Walk to dry land, get shackle, shackle right hindleg	.48	17	.56
Hoist and land on rail, walk to stunner's walk[1]	.27	15	.31
Open stun pen door, walk to entrance door to pens	.08	15	.09
Total	1.44	....	1.66
Stick, remove forelegs:			
Position carcass, open dewlap, stick and bleed, release rail stop	0.25	17	0.29
Remove lips, aside	.26	16	.30
Remove ears, aside	.17	17	.20
Remove forelegs, aside	.26	17	.30
Release rail stop to move carcass to high-bench area	.04	15	.05
Remove horns (ax or hydraulic cutter and knife) (4/10)	.08	15	.09
Wash hands and tools	.07	15	.08
Total	1.13	....	1.31
1st hindleg, 1st transfer:			
Rip leg pattern, skin hindleg, cut gam, rip tail	0.44	17	0.51
Get hydraulic cutter, remove leg, aside	.11	15	.13
Pull rail stops, hoist hook in gam, hoist, release shackle, lower hoist	.21	15	.24
Skin free leg (cut leg pattern)	.36	17	.42
Remove leg, aside	.11	15	.13
Move spreader and trolley into position, hook in gam of right leg	.10	15	.12
Total	1.33	....	1.55
2d transfer, skin flanks, rounds:			
2d transfer (put trolley on bare spreader hook, hook in free gam, raise hoist, release hoist hook, complete transfer)	0.28	15	0.32
Open crotch to belly area, get mechanical knife, skin each flank and round	.77	17	.90

See footnotes at end of table.

TABLE 10.—*Productive labor required per head for plant D kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
2d transfer, skin flanks, rounds—Continued:			
Swivel carcass, use hand knife to clear bung area to base of tail, wash	.26	17	.30
Total	1.31	....	1.52
Rim-over, saw brisket:			
Release bung, get string and tie bung, turn carcass	0.27	17	0.32
Open hide to brisket, rim-over brisket each side 6-inches	.50	17	.59
Saw brisket, sterilize saw, aside	.17	15	.20
Raise platform, pull rail stops	.20	15	.23
Occasionally move trolleys along rail to adjacent station	.01	15	.01
Total	1.15	....	1.35
1st hide puller:			
Hook chain to rump hide, lower platform	0.11	15	0.13
Get mechanical knife, follow hide pull, aside knife	.70	15	.80
Raise platform, release hide chain	.27	15	.31
Total	1.08	....	1.24
2d hide puller:			
Attach chain to rump hide, lower platform	0.11	15	0.13
Get mechanical knife, follow hide pull to neck area	.70	15	.80
Get shocker, shock carcass, aside shocker and mechanical knife, raise platform, score flank, release hide chain	.27	15	.31
Total	1.08	....	1.24
Head:			
Trim brisket and clear weasand	0.17	17	0.20
Trim horn area	.10	15	.12
Tie weasand, move carcass	.21	18	.25
Sever head to hang by esophagus	.21	17	.25
Carry head to head wash cabinet, return (4/10)	.08	17	.09
Wash hands and tools	.10	15	.12
Total	.87	....	1.03
Eviscerate:			
Lower carcass, open belly, eviscerate into paunch truck	0.71	17	0.83
Remove liver, pluck into truck tray	.21	17	.25
Pop kidneys, check nodes	.19	17	.22
Push paunch truck 10 feet to pluck workup station, return, wash hands	.14	20	.17

TABLE 10.—*Productive labor required per head for plant D kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Eviscerate—Continued:			
Raise hoist, pull rail stops to move carcass to and from station	.14	15	.16
Wait on inspector (3/10)	.01	15	.01
Total	1.40	....	1.64
Saw carcass:			
Remove tail, aside to paunch truck worker	0.08	15	0.09
Get saw, saw carcass, trim rump at tail, complete sawing, aside saw	.85	17	.99
Raise platform, guide release of sides from spreader rail	.17	15	.20
Return spread to spreader return rail	.04	15	.05
Total	1.14	....	1.33
Trim:			
Trim side, release rail stop	0.42	15	0.48
Trim other side, release rail stop	.42	15	.48
Use mechanical scriber to scribe side 1	.12	15	.14
Scribe side 2	.12	15	.14
Total	1.08	....	1.24
Weigh:			
Trim carcass neck, remove windpipe section, position carcass, puncture blood pocket	0.39	17	0.46
Record weight	.15	15	.17
Release rail stop, get tags and pin, pin tag on carcass, push sides on rail	.18	18	.21
Trim carcass (3/10)	.06	15	.07
Wash down area (1/10)	.09	15	.10
Wash hands and tools (2/10)	.01	15	.01
Total	.88	....	1.02
Wash (carcasses and area): Geared to line speed (hydraulic platform)[2]	1.66	....	1.66
Total	1.66	....	1.66
High-shroud:			
Pull rail stop, peg neck, get shroud, 5 pins, and strap on side 1	0.50	15	0.58
Shroud side 2 same	.50	15	.58
Get armload of shrouds (40–50) 1/50	.01	16	.01
Get supply of pins	.01	15	.01
Total	1.02	....	1.18

See footnotes at end of table.

TABLE 10.—*Productive labor required per head for plant D kill-floor operations*—Continued

Operation and timed element	Base time (man-minutes)	Fatigue and personal allowance (percent)	Productive time (man-minutes)
Low-shroud:			
Pin low shroud (5 pins), tag inside carcass	0.25	15	0.29
Push to cooler	.20	20	.24
Pin side 2, low shroud	.25	15	.29
Push to cooler	.20	17	.23
Walk to shroud room, stack shrouds (1/50)	.01	15	.01
Total	.91	....	1.06

[1] Stun and dry-land area located 8 feet below level of rest of kill floor.
[2] Not timed (assumed line speed).

During the studies, carcass weights ranged between 401 and 838 pounds; the average dressed weight was 645 pounds. The plant employed 15 line workers and 6 support workers.

DISCUSSION AND ANALYSIS

The kill floor in plant D was the most efficient studied. Line production was 2.41 carcasses per man-hour, and total kill-floor work, including support work, was performed at a rate of 1.72 carcasses per man-hour. Factors contributing to the high efficiency of this floor were (1) a compact, well-designed work area, (2) well-trained, steady workers, (3) good equipment, and (4) payment of incentives.

The "drive, stun, dry-land" operation was the pace-setting job for line operations, with a productive time of 1.66 man-minutes. Normally, this should not be the pace setter, for reasons discussed later.

This efficient plant spent only 24.90 man-minutes of line time per carcass, the least of any plant studied (table 11). The unproductive time, 4.87 man-minutes per carcass, is also on the low side. This represents an average job-related wait time of 0.32 man-minute per line worker.

TABLE 11.—*Crew organization and labor requirements, plant D*

[36 head per hour; gravity on-the-rail system; down-pull hide removal unit]

Operation	Crew size	Labor requirements (man-minutes)		
		Productive	Unproductive	Total
Drive, stun, dry-land	1	1.66	0	1.66
Stick, remove forelegs	1	1.31	0.35	1.66
1st hindleg, 1st transfer	1	1.55	.11	1.66
2d transfer, skin flanks, rounds	1	1.52	.14	1.66
Rim-over, saw brisket	1	1.35	.31	1.66
1st hide puller	1	1.24	.42	1.66
2d hide puller	1	1.24	.42	1.66
Head	1	1.03	.63	1.66
Eviscerate	1	1.64	.02	1.66
Saw carcass	1	1.33	.33	1.66
Trim	1	1.24	.42	1.66
Weigh	1	1.02	.64	1.66
Wash carcass	1	1.66	0	1.66
High-shroud	1	1.18	.48	1.66
Low-shroud	1	1.06	.60	1.66
Total	15	20.03	4.87	24.90

LINE OPERATIONS

Unusual conditions were present on plant D's kill floor, making the "drive, stun, and dry-land" operation the pace setter. A floodlight high above the stun pen seemed to catch each animal's attention as it entered the pen. Since there was considerable balking on the part of the animals, it was assumed the floodlight was the source of the problem. Another light was placed at the end of the stun pen in an attempt to hold the animals' attention, but timestudies did not indicate that the second light made any significant difference in stunning time.

The first variation in procedure related to the down-pull hide removal unit is indicated in the

"stick, remove forelegs" operation (normally, the head is also hand-skinned at this point.) It is necessary to remove horns, lips, and ears at this location so that the unit will have a smooth pull over the head. An advantage to the down-pull unit, other than saving skinning time, is that it increases the usable cheek and head meat; one plant in this study was getting one-half pound more per head. It also appeared to eliminate the problem of hair and debris falling on the carcass, which is objectionable in inspection. No attempt was made to evaluate scores or other hide damage. The unit does require that an electric shocker be used to stiffen the carcass (to prevent vertebrae separation) while the hide is being pulled over the head (fig. 13).

High-bench work, which included "first hind-leg, first transfer" and "second transfer, skin flanks, rounds," was the best high-bench arrangement evaluated. The personnel in this area were ideally suited for the efficient balance of job elements.

Studies indicated that the down-pull unit could effectively and consistently process up to 50 head of heavy cattle per hour at the prevailing pull rate. Whether faster pull was feasible while maintaining carcass quality and appearance was not specifically evaluated.

PN—4690

FIGURE 10.—Down-pull hide removal unit in up position, ready to begin hide removal.

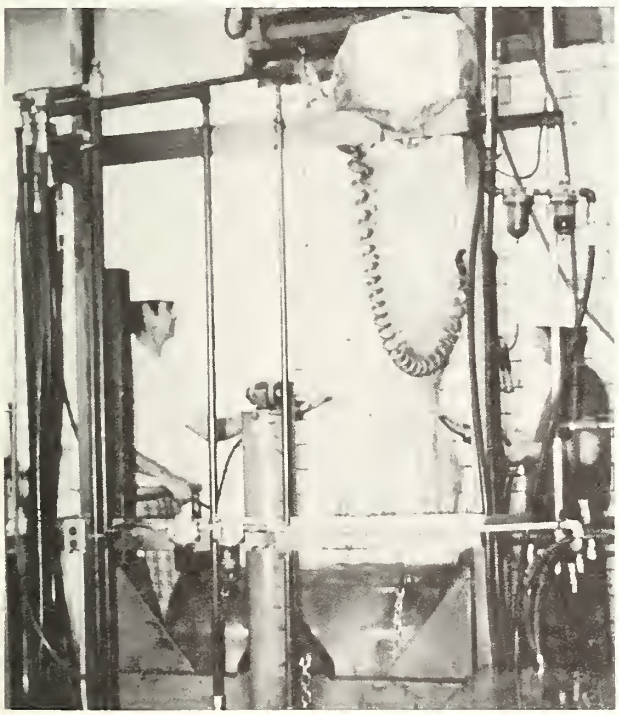


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FIGURE 11.—Down-pull unit in position for head skinning

PN—4692

FIGURE 12.—Head removal station in plant using a down-pull hide removal unit. Head-wash cabinet is nearby.

PN—4693

FIGURE 13.—Shocker in use as down-pull unit pulls hide overhead. Note rigid position of forelegs.

On this line, the head was removed after hide-puller operation, resulting in more bleeding at this stage than usual. It may be desirable to redesign bleeding areas for new plants that wish to use this equipment.

A problem in floor design that was evident at plant D was that the kill floor was too narrow to permit proper processing of heads or the proper use of a conveyor from head wash to head trim; consequently, there was some lost time in the support work of head wash and head trim. The remaining line operations were balanced about as well as could be expected, given the plant layout. Table 12 presents the summary of labor requirements per head for the kill-floor operations.

COMPARISON OF RESEARCH RESULTS ON BEEF KILL FLOORS

Table 13 summarizes some of the data acquired from case studies of 13 representative on-the-rail beef kill floors in the United States, slaughtering at rates between 15 and 50 head per hour. Equipment included gravity and powered rail systems, down-pull and up-pull hide removal units, a variety of saws, hydraulic cutters, shackle and spreader return systems, and hydraulic and stationary work platforms; work was variously arranged depending upon personnel, equipment, and layout.

TABLE 12.—*Summary of labor requirments per head, plant D*

[36 head per hour; gravity on-the-rail system; down-pull hide removal unit]

Operation	Labor requirements (man-minutes)		
	Productive	Unproductive	Total
Line	20.03	4.87	24.90
Support	9.96	....	9.96
Total	29.99	....	34.86

Several variations in means of hanging and moving carcasses on the rail through the dressing operations were noted. One plant compensated for its high rails by using long trolley hooks to lower the carcass to a working level (fig. 14). Plants that did not use swivel spreaders on the gravity-system rails had to locate workers on both sides of the line (fig. 15). Fortunately, space for this arrangement was available on the kill floor. Most of the kill floors in this country are overcrowded, and some inefficiencies can be attributed to this fact. Crowded conditions are particularly noticeable and seem to be magnified when barrels are used for offal and must be moved around the floor (fig. 16).

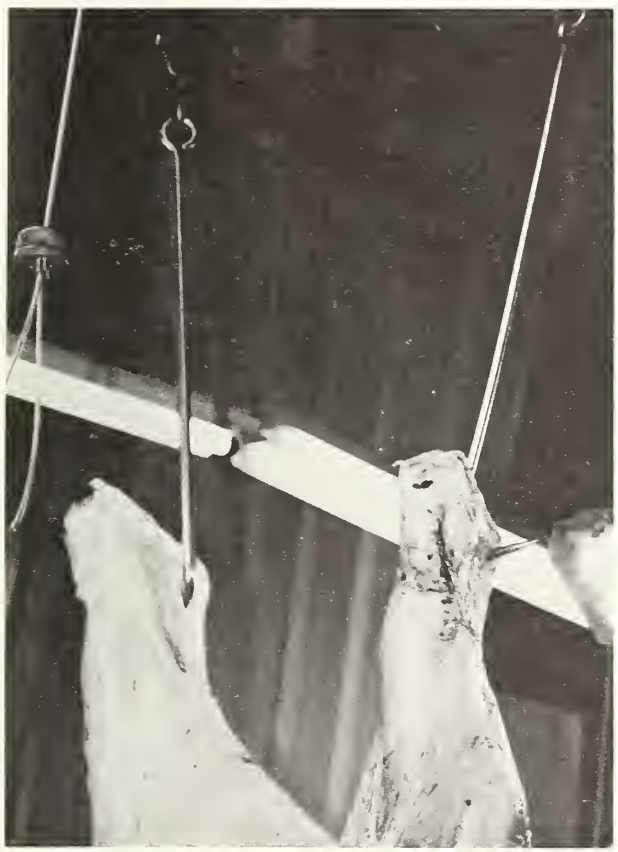
Most of the powered rail systems observed in this study used intermittently powered chains and swivel spreaders. Timing of the conveyor movement is determined and preset by supervision. In powered systems, the inspector can stop line movement if necessary.

It is very important to maintain equipment such as carcass saws, dehiders or mechanical knives, hydraulic equipment, and powered conveyors in top condition to maintain high efficiency. This is a formidable task for plant maintenance because of the highly corrosive substances the equipment is exposed to and the rough treatment it must withstand during the normal course of operation. Proper equipment for each job is also important. For example, one

TABLE 13.—*Summary of case study data from selected on-the-rail beef kill floors*

Plant No.	Carcass weight (pounds)		Kill rate (head per hour)	Line productivity (head per man-hour)		Standard kill-floor time[2] (man-min per head)	Production rate[3] (pounds per labor dollar
	Average	Range		Actual	Standard[1]		
1	648	386–840	14	1.38	1.52	59.25	87.49
2	529	385–779	23	1.67	1.59	48.42	87.40
3	432	312–690	28	2.19	2.19	37.98	90.99
4	658	410–998	29	1.80	1.70	50.60	104.03
5	350	200–726	31	1.87	1.80	49.00	57.14
6	613	310–774	31	1.68	1.71	54.60	89.82
7	617	387–820	33	1.80	2.06	44.46	111.02
8	654	619–686	39	2.58	2.16	38.85	134.67
9	605	435–789	40	2.70	2.29	34.44	140.53
10	654	401–838	41	2.72	2.41	34.86	148.02
11	596	525–670	42	2.01	2.11	41.85	113.93
12	579	392–627	45	2.52	1.83	58.48	79.21
13	489	294–800	48	2.66	1.97	42.45	92.16

[1] Productivity after raw timestudy data have been leveled and allowances added.
[2] Total leveled time including line and support workers.
[3] Determined by the formula: (average carcass weight÷standard total kill-floor time) × (60 minutes per hour÷$7.50, the assumed total hourly labor cost including fringe benefits).



PN—4694

FIGURE 14.—Long trolley hooks used to compensate for high overhead rails.

PN—4695

FIGURE 15.—Rigid support on gravity rail system trolleys. Note that platforms are required on both sides of line.

PN—4696

FIGURE 16.—Barrels used for inedible offal create congestion and contribute to inefficiency.

plant study showed that, with a heavy-duty carcass saw, carcasses of similar weights could be split 0.10 minute (6 seconds) faster than with a lightweight saw.

Most of these plants slaughtered a variety of animal classes. Three of the thirteen plants specialized in cows and one, in heifers; the other nine slaughtered a larger percentage of steers than heifers. The latter plants also averaged about 10 percent cows and bulls.

Data collected in more than 70 on-the-rail slaughter plants since 1960 indicate that the most common causes of inefficiency in slaughtering cattle are as follows: (1) poorly arranged job elements or personnel misfits (sometimes shifting a worker to a different job can solve a production problem); (2) inferior equipment; (3) poor maintenance; (4) dissatisfied workers; (5) poor layout; and (6) lack of communication or understanding between management and inspection.

The adoption of the hide puller in recent years has helped packers to increase their yield and improve hide quality. Before installation of a down-pull hide removal unit at one of the plants listed in table 13, 20 to 22 pounds of fleshings were left on the average hide. After the hide puller was installed, an average of only 8 to 10 pounds of fleshings were left on hides. Several plants reported an increase of one-half to one pound in head-meat yield after installing a down-pull unit.

Several methods and job arrangements were used in the plants studied in carcass wash and shroud operations. Figure 17 shows a type of nozzle used in many plants. A few plants used a similar nozzle for low wash and a lighter spray or large flow for high wash. One plant even designed its own wash nozzle in an attempt to obtain more efficient cleaning. No attempt was made in this study to evaluate the efficiency of the various washing methods and equipment, since this step is largely controlled by inspection requirements. Some plants used stationary platforms from which the workers did the washing and shrouding, while others used hydraulic platforms. Efficient work can be done with both types of equipment; however, hydraulic plat-

PN—4697

FIGURE 17.—One type of nozzle used in carcass washing.

forms allow more flexibility. Some plants attached considerable value to enhancing carcass appearance and spent some extra time at this task. Oxtails were cut off at various stations, usually at the carcass-split area, but some plants sever the tails only enough to get them out of the way for sawing the carcass and leave them on the side to chill in the cooler.

Plants 12 and 13 shown in table 13 were separate studies made of the same plant with the same personnel. Plant 12 represents the slaughter of 40 percent steers and 60 percent heifers. Plant 13 represents the slaughter of 100 percent cows. Efficiency increases when light cows are processed regardless of the fact that some jobs may be more difficult. This increase in productivity is attributable to several factors, such as absence of a need to shroud carcasses, peg necks, or otherwise take particular care to enhance the carcass appearance, and the lighter carcass weight. Trimming time increases when cows are processed, but, in this case, not enough to offset the other factors. Large Holstein cows (over 700-pound carcass weight) present real problems to a plant whose line is not designed to handle the long carcass.

A few plant owners expressed concern about maintaining carcass quality when the line is producing at a high rate. Most workers have a tendency to become sloppy when the production rate is increased above their normal capabilities, and this is an important consideration when standards are being set for a kill line. Quality as well as yield should concern both management and employees in this industry. In some plants, a program of planned instruction to increase the employee's knowledge of methods to attain and maintain quality would be helpful.

It is interesting to note that only four of the plants included in table 13 (1, 6, 7, and 11) were operating at productivity levels considered to be below standard for their classes. In each case, the substandard productivity was directly attributable to specific conditions. Plant 1 was using new equipment and methods to which the employees had not become accustomed. A similar situation prevailed in plant 6, but line imbalance also was an important factor. Plant 7 was trying to adjust to a new hide puller and also had problems arising from extremely variable cattle weights. Plant 11 had labor problems that prevented its attaining standard productivity, though it was well equipped and organized in other respects.

Production rates shown in the last column of table 13 have a range of 148.00 to 57.14 pounds for each labor dollar spent. The difference, about 91 pounds, illustrates the wide variance among plants slaughtering cattle with modern systems of processing. The high average of 148 pounds per labor dollar was attained by a plant paying incentives to its kill-floor personnel, utilizing a down-pull hide removal unit, and having highly skilled personnel and an extremely compact layout.

On the other hand, the plant with low production (attaining only 57.14 pounds per labor dollar) slaughtered low-grade cattle, paid low hourly wages, used an up-pull hide removal unit, and employed unskilled personnel in some jobs. Obviously, the low production rate could not have been tolerated if high wages had been necessary at this plant.

The standard total kill-floor time shown in table 13 varied from a low of 34.44 man-minutes per carcass to a high of 59.25 man-minutes per carcass. Although not shown in the table, the standard productive line time for these plants varied from 24.90 to 39.50 man-minutes per carcass. These latter figures are more significant for comparison purposes because similar work is involved. The larger figures may include more or different support work, depending upon the plant. They do show, however, the time variance among packers' slaughter operations.

The 13 plants had crews totaling from 15 to 34 workers on the kill floor. Line workers varied from 10 to 21.

To illustrate the magnitude of the effect on a plant's production of only slight differences in productivity between similar plants, analysis of a week's production at the standard productivity rate for plants 9 and 10 shows a difference of 122,119 pounds. The difference between plant 1 and 10 would amount to 957,715 pounds per week.

Of course, plant management could not remain competitive under conditions as variable as these unless they were able to make some adjustments to compensate for deficiencies. High labor and high cost areas must take advantage of the most modern systems and best personnel to remain competitive.

Since there are hundreds of variables that

enter into the complex system of marketing the beef animal, it is apparent that a very important factor in maintaining an efficient, competitive meatpacking plant is good, progressive management that can recognize problems and take action to rectify them.

SUMMARY

Many factors can affect the efficiency of a cattle slaughter facility, but one of the most significant found in this research is the wide range of cattle weights and variations of cattle classes processed during a day's kill. Other problems such as poor management, poor layout, labor problems, cattle condition, outdated or poorly designed equipment, and inspection requirements were found to have an impact on efficiency in many plants; however, in most cases, these problems could be resolved. Few packers, on the other hand, deal effectively with the problems of wide weight ranges (67 to 588 pounds observed during the study) and classes randomly scheduled on kill floors. When market conditions permit a packer to specialize in a narrow weight range, benefits in higher productivity rates are immediately apparent.

Undoubtedly, on-the-rail systems of slaughter, widely adopted in recent years, have contributed much to kill-floor efficiency, but management could benefit greatly from more time spent investigating available equipment and new processes to determine the best system for a particular plant.

Research in 25 on-the-rail plants using hide pullers and slaughtering at a rate of 50 or fewer cattle per hour indicated much can be done by management to increase productivity through small adjustments of job elements within a kill-floor crew. An important consideration in achieving a more balanced production line is the employment of the right man for a particular job.

Efficiency tends to improve as the rate of kill increases in well-managed plants. Standard line efficiency (excluding support operations) varied from 1.52 carcasses per man-hour to 2.41 carcasses per man-hour. The same extremes were evidenced in the total standard time (productive man-minutes) spent on each carcass by line personnel. The times varied from 24.90 man-minutes per carcass in one of the larger volume plants to 39.50 man-minutes per carcass in the lowest volume plant. The difference, 14.60 man-minutes per carcass, could amount to more than $50,000 annual additional labor cost for the small-volume plant if its wage rate were the same as that of the larger volume plant ($7.50/hour including fringes).

Unproductive time is another variable that often can be reduced by simple rearrangement of job elements or personnel. Unproductive line time varied from 2.30 to 8.78 man-minutes per carcass in the plants studied. Here again, the small-volume plant suffered the most unproductive time, and it could mean a substantial annual savings to the plant if this time could be significantly reduced. Research data indicate that management should strive to keep job-regulated wait time (unproductive) to less than 25 percent of the total line productive time to achieve efficient line balance.

Since so many variables enter into the determination of cattle kill-floor efficiency, the low-efficiency packer, to remain competitive, must find ways to process cheaper than high-efficiency plants.

U. S. GOVERNMENT PRINTING OFFICE : 1976 O - 215-150